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COMPRESSOR HEALTH MONITORING USING IOT

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ABSTRACT

Any device or machine that needs regular monitoring and inspection for its better life and maintenance. Condition monitoring of machines in time and frequency domain is definitely necessary to maintain the reliability. Condition monitoring is the way toward observing a parameter of condition in machinery (vibration, temperature and etc.), with a specific end goal to recognize a significant change which is indicative of a developing fault. It is a major component of predictive maintenance and for reducing downtime of a compressor. IOT is the best method and technology in the present world for continuous condition monitoring of any machine. We have used sensors like MEMS for sensing abnormalities in misalignment, non-linearity, vibrations and temperature in compressors and the change in signals will be sent to the cloud through wifi module ESP 8266. These signals are in time domain sequence. The time domain sequence is analyzted and converted into the frequency domain by using Fast Fourier transform.

KEYWORDS: Portable Reciprocating Air Compressor, Mems(micro electro mechanical systems),WIFI Module ESP8266,Vibration Signals & Fault Diagnosis

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Original Article

INTRODUCTION

A compressor is a mechanical device that is used to compress the air from lower pressure to that of higher pressures which are used for operating machines like turbines etc. for power output. Compressors are used in wide range of industries in a wide range of applications. Safe asset sparing task of perilous generation apparatus, especially responding compressors, is incomprehensible without their wellbeing checking continuously. A standout amongst the most generally utilized methods depends on vibration investigation. An extensive variety of strategies for getting ready vibration signals have been proposed and have shown to constrain in condition watching and diagnostics of different kinds of equipment [1]. The primary parameter that serves to sufficiently and precisely assesses the condition of hardware basic parameters is vibration[2]. Rotor unbalance is the most widely recognized reason for vibration in turning apparatus. Unreasonable unbalance can prompt weariness of machine parts, and additionally can cause wear in orientation or inside rubs that can harm seals and debase machine execution. The condition observing has turned into a compelling procedure to lessen the support cost and enhance the accessibility of frameworks[3].

Condition observing of a framework includes the assessment of the soundness of a framework and its segments through the investigation and translation of signs gained from sensors. The principle motivation behind condition observing is to recognize the nearness of the deficiencies in hardware at the most punctual conceivable

stage. It envelops location, analysis furthermore, guess keeping in mind the end goal to decide the remaining safe working existence of the machine before breakdown or disappointment happens. A successful checking also, upkeep framework ought to be fit for checking the working states of a machine, issuing progressed cautioning of conceivable blames, and anticipating the lie traverse of a debased machine segment before an aggregate breakdown. With the correct condition observing, the unwavering quality of the framework will be progressed[4]. Major failures in compressor[5] as shown in theFigure.1

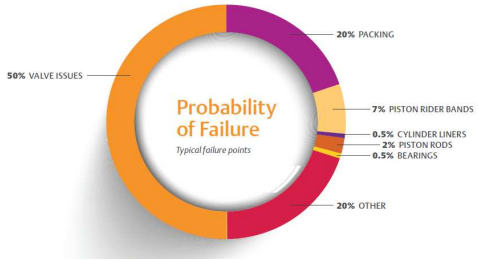

Figure 1: Probability of Failure in the Compressor

As compressors contain a various heading, gears, and other mechanical parts, it is typically irrational and monetarily unfeasible to use overabundance structures, in this way requiring continuous checking and diagnostics. The principle information utilized for the examination is the vibration signals, since the vibration signals relate directly to the working condition of the compressor. They can be utilized to distinguish issues before they make genuine harm the general procedure or prompt unscheduled downtime. The vibration signs can give data with respect to decaying or on the other hand deficient orientation, mechanical detachment, and the worn or broken apparatuses. Vibration examination can in like manner distinguish misalignment or unbalance before these conditions bring about bearing or shaft disintegrating[1]. Numerous procedure enterprises have discovered vibration-based condition checking is the most an ideal approach to limit upkeep costs and to maintain a strategic distance from sudden creation interferences.

The principle goal of this paper is to represent the different flag handling methods and a PC program produced for a compressor condition checking and blame forecast framework, utilizing the right now accessible on cloud utilizing IOT device by the MPU6050 sensor and wifi module, which incorporates temperature, vibration and different process.

BRIEF POR TRAYAL OF THE COMPRESSOR AND DATA ACQUISITION SYSTEM

Compressor

Compressors are fundamental equipment in petrochemical plants. Disfigurements and breakdowns of a compressor may come to fruition in the whole shutdown of age, and can provoke basic budgetary hardship. It is critical to screen their working conditions progressively amid activity. Modernized checking and vibration data framework which takes into consideration the appraisal of the mechanical state of pivoting apparatus.

Figure 2: Schematic Diagram of Portable Air Compressor

The framework constantly measures and screens an assortment of framework factors (vibration, temperature and different process parameters), giving critical data to ahead of schedule recognition and recognizable proof of a hardware issue, for example, unevenness, misalignment, shaft split and bearing disappointments.

Data Acquisition

The fundamental setup of the information, procurement framework is displayed in Figure 3.

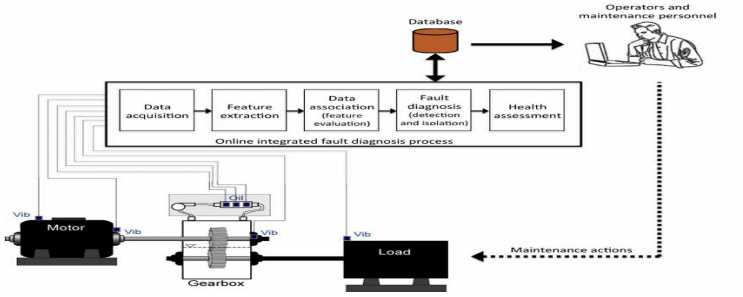

Figure 3: The Configuration of the Data Acquisition System

The information accessible for compressor condition checking comprises of (1) vibration; (2) temperature.

OBJECTIVE

The principle goal of the task is to build up a few flag handling methods and make an Arduino program to perform on-line, constant condition, observing and blame identification of the compressor utilizing the information from the mems sensor sent to the IOT checking framework. To accomplish this goal, the accompanying advances have been taken:

- Develop an Arduino code to send the signals from mems sensor to the cloud.
- Implement a time domain signals from mems sensor for foreseeing approaching faults, from which the best maintenance plan can be resolved.
- The wifi module ESP 8266 sent those time domain signals to the Ubidots IOT platform Internet of Things
- Convert those time domain signals to the frequency domain by using Fast Fourier transform(FFT) for the vibration and temperature[4] profile related with different disappointment modes to develop a learning base for itemized blame source conclusion.
- Finally, compare both ideal signal and fault signals for a variance of unbalance and temperature from the frequency graphs. So if the signal crosses the peak value then we identify that where the fault occurs.

SENSOR USED FOR MEASURING VIBRATIONS AND TEMPERATURE SIGNALS

As we need continuous condition monitoring, we used an IOT technique for it. We have selected MEMS sensors for this project. MEMS sensor. MEMS are micro electro-mechanical systems which consist of accelerometer, gyroscope, magnetometer and thermometer printed on its circuit boards.. The MPU-6050 gadgets consolidate a 3-axis gyroscope and a 3-axis accelerometer on a similar silicon bite the dust, together with a locally available Digital Motion Processor. The actual mem sensor is shown in figure 4

Figure 4: Mpu 6050 Sensor

SIGNALS FROM SENSOR TO CLOUD

In this project, we have used ESP8266 as wifi module for continuously sending the signals from MEMES to the cloud for display of results in smartphone or laptop. WIFI ESP8266 is the leading platform for the internet of things (IOT). ESP8266 is one of the wifi microchips with reasonable cost and with full TCP/IP stack and microcontroller capability. It is a product from Shanghai based Chinese manufacturer.

Wifi module ESP8266 can be used for sending and collecting data. Once it is configured. It can be used as a client or an access point. It can handle multiple connections for sending and collecting data from different IP address[6].

ANALYSIS OF SIGNALS

Fast Fourier transform FFT is used for analyzing the signals produced by MEMS. The signals from MEMS will be sent to cloud through wifi module and the data coming from the cloud will be coming to our smartphone or laptop and the data which we get will be in a time domain and this will be converted into a frequency domain by FFT analyzer.

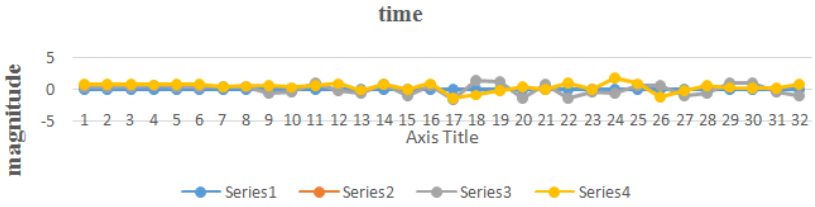

Figure 5: Shows Time Domain Signals from Mems which were Kept on the Motor without Load

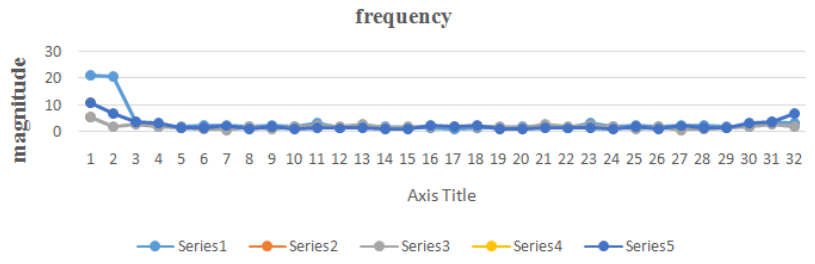

Figure 6: Shows Frequency Domain Signals Obtained from Fourier Transform of above Signal

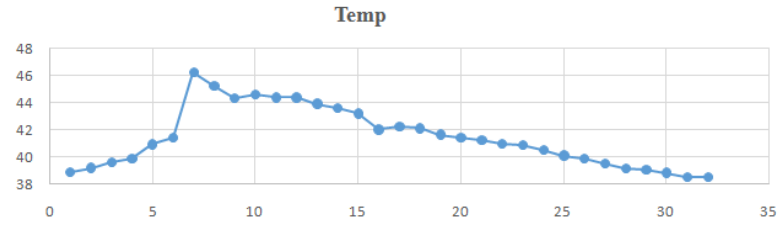

Figure 7: Shows Temperature Signals from Mems which were Kept on the Motor without Load

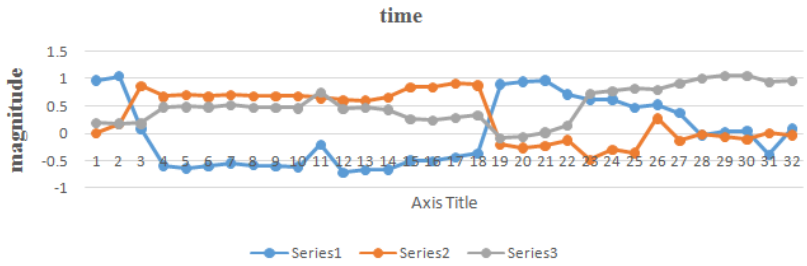

Figure 8: Shows Time Domain Signals from Mems which were kept on the Piston Cylinder without Load

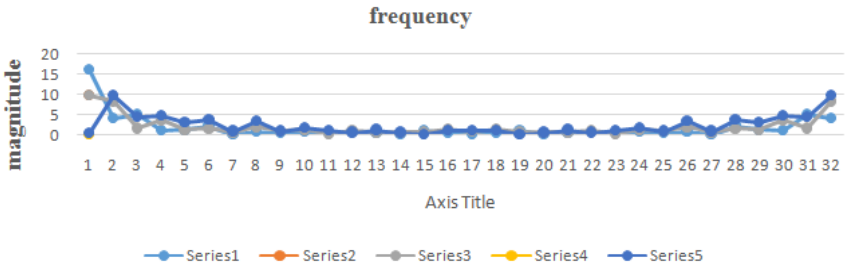

Figure 9: Shows Frequency Domain Signals Obtained from Fourier Transform of above Signal

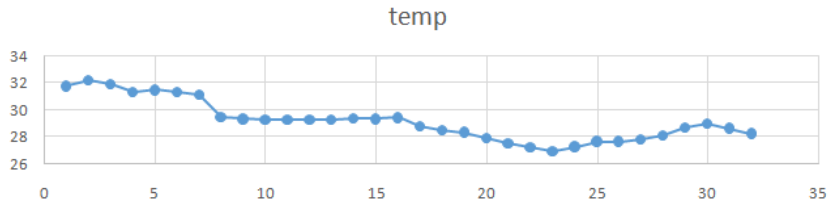

Figure 10: Shows Temperature Signals from Mems which were kept on the Piston Cylinder without Load

DATA PROCESSING

The information which is gotten from the compressor through mems and other hardware is downloaded from the cloud to the work area and it stacked in the exceed expectations sheet. The information which we got from the cloud is time-space. Thusly, play out the Fourier examination, remembering the true objective to change the data from time-space to repeat region. A quick Fourier change (FFT) is an estimation that examples a flag over some timeframe (or space) and these examples are changed over it into its constituent recurrence parts. These parts are single sinusoidal movements at various frequencies each with their own greatness and stage. The change represented as appeared in the figure. Over the era assessed, the flag contains 3 specific transcendent frequencies.

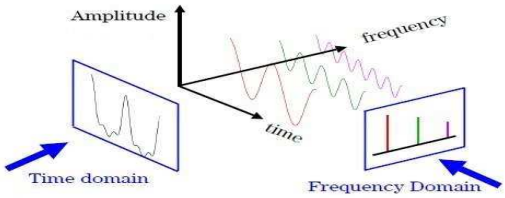

Figure 11: Shows Conversion of Time Domain to Frequency Domain

The Fourier Transform (FT) of the capacity f (x) is the capacity F(w), where

$$F(\omega) = \int_{-\infty}^{\infty} f(x) e^{i\omega x}\, dx$$

An FFT count enlists the discrete Fourier change (DFT) of a progression, or its Inverse (IFFT). Fourier examination changes the flag from its local area to a portrayal of the recurrence space and the other way around. It is important to change over the time-space to a recurrence area in light of the fact that by looking the recurrence esteems we can undoubtedly distinguish the most extreme recurrence esteem which shows the nearness of flaws.

RESULTS AND DECLARATION

Figure 6 indicates recurrence space signals acquired by applying Fourier changes to the time area flag when mems are set on the motor which is appeared in Figure 5. Since these signs are gotten when there is no load on the compressor, the signs acquired are of high when compared with the signs which are acquired within the sight of a load as appeared in the Figure 13.

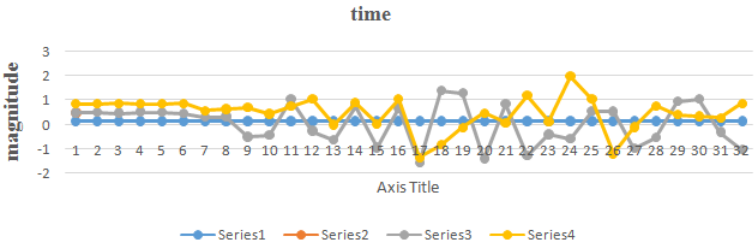

Figure 12: Shows Time Domain Signals from Mems which were kept on Motor with Load

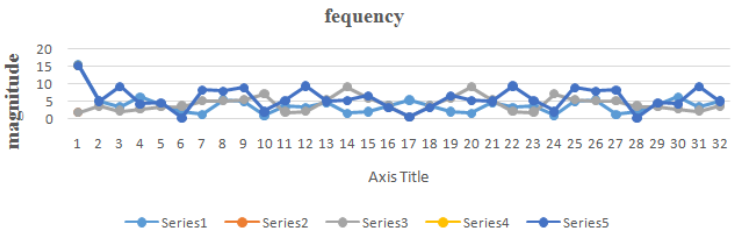

Figure 13: Shows Frequency Domain Signals which were Obtained from Fourier Transform of above Signal

Figure 7 shows the less temperature when we place the mem sensor on the motor without having any load. By comparing figure 7 with the Figure 14 the temperature is raised when there is a load on the motor

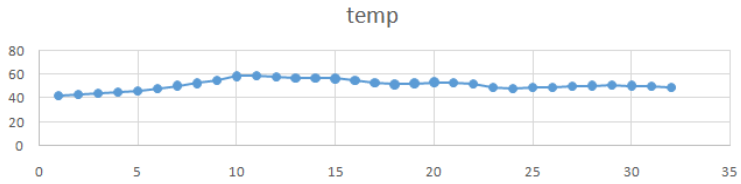

Figure 14: Shows Temperature Signals in the Motor with Load

Figure 9 indicates recurrence space signals acquired by applying Fourier changes to the time area flag when mems are set on outside the piston which is appeared in Figure 8. Since these signs are gotten when there is no load on the compressor, the signs acquired are of high when compared with the signs which are acquired within the sight of a load as appeared in the Figure 16.

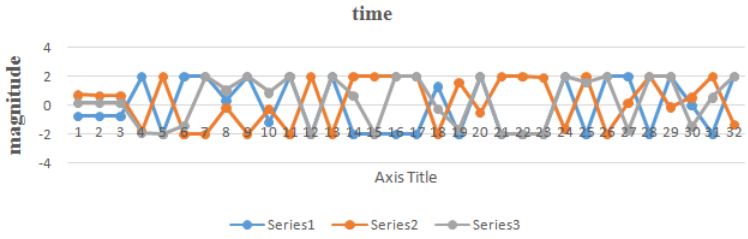

Figure 15: Shows Time Domain Signals from Mems which were kept on the Piston Cylinder with Load

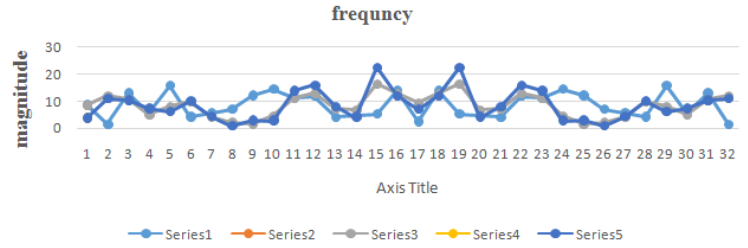

Figure 16: Shows Frequency Domain Signals which were Obtained from Fourier Transform of above Signal

Figure 10 shows the less temperature when we place the mem sensor on the outside of piston without having a load. By comparing Figure 10 with the Figure 17 the temperature is raised when there is a load on the piston.

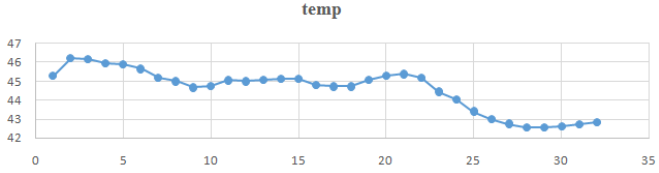

Figure 17: Shows Temperature Signal in the Piston Cylinder with Load

TABLE

Table 1: Peek Esteems from all the Recurrence Plots Including both Ideal and Load Conditions

Frequencies				
	On Motor		On piston	
Axis	Ideal	Load	Ideal	Load
x	21.2	6.26	16.2	15.65
y	5.2	9.08	9.8	16.33
z	10.7	15.27	9.69	22.46
Temp	46	58.7	42.2	32.2

CONCLUSIONS

As we perform an experiment on the portable air compressor and also, a machine is under good condition. So we didn't identify the misalignment in the experiment. It can be found on the motor which having long shafts by placing mems on both sides of the shaft. Using the vibration data acquired from a ubidots IOT software for the data acquisition system, a condition monitoring and fault detection program for a compressor has been developed. The techniques include time domain analysis in frequency domain analysis. We observe that the values increased in accelerometer readings and temperature readings by comparing both the ideal and load condition signals as we observe that the vibrations are more in load condition and the temperature is also increasing, so that incipient failure is observed at the exact location and reduce the downtime of the machine and improve its reliability. It is beneficial to upgrade current systems to IOT based Technology to reduce wiring, improve ease and accuracy, of course at some extra cost in equipment and training.

REFERENCES

1. *Y. Zhang, J. Jiang, H. Bryan, and M. Flatley, "Condition Monitoring and Fault Detection of a Compressor Using Signal Processing Techniques '," Am. Control Conf., pp. 4460–4465, 2001.*
2. *V. N. Kostyukov and A. P. Naumenko, "About the Experience in Operation of Reciprocating Compressors under Control of the Vibration Monitoring System," Procedia Eng., vol. 152, pp. 497–504, 2016.*
3. *G. R. Rameshkumar, "Investigation of Mechanical Faults in Rotating Machines Using Condition Monitoring Tool," vol. 2, no. 11, pp. 40–46, 2015.*
4. *Krishnan, Jyotsna. "Adaptation as Intersemiotic Translation: A Study Focussing on the Visual Text Kaliyattom, An Adaptation Of Othello." HVW,-+ $06 3.2 (2015): 47-52.*
5. *M. M. Chapman, "Monitoring Reciprocating Compressors."*
6. *Emerson Process Management, "Reciprocating Compressor Monitoring," 2015.*
7. *Z. Yue-zhai and C. Xiao-ying, "Proceedings of International Conference on Soft Computing Techniques and Engineering Application," vol. 250, pp. 11–17, 2014.*